Appendix C: Models and Tools[1]

This appendix describes the various models and tools used to support the CNS/ATM Enhancement study. The tools are listed in alphabetical order.

Emissions and Dispersion Modeling System (EDMS)[2]

EDMS is a combined emissions and dispersion model for assessing air quality at civilian airports and military air bases. The FAA in cooperation with the US Air Force developed the model. The model is used to generate an inventory of emissions generated by aircraft operations at the airport and to calculate pollutant concentrations in this environment.

Today, EDMS is the FAA-preferred model for air quality assessment at the airport and air bases. It is one of the few air quality assessment tools specifically engineered for the aviation community. EDMS includes emissions and dispersion calculations, a database of emission factors for aircraft, ground support equipment, and reporting module.

ETMS Parser

The ETMS Parser is one component of the National Airspace Resource Investment Model (NARIM). The tool is used to parse raw Enhance Traffic Management System (ETMS) data and output formatted data. The ETMS data consist of messages received from different centers in the NAS. The data falls into two categories, including flown and filed flight information. The filed and flown messages are used to piece together flight information including aircraft ID, aircraft type, origin and destination, and planned and flown trajectories. The result from the parser is a clean and formatted data set that is used as input into the FDG, NASPAC, and OPGEN.

Future Demand Generator (FDG)[3]

The FDG is one component of the NASPAC model. The tool is used to grow future traffic based on today's traffic level and projected growth rate. The FDG uses the Fratar algorithm to forecast future scheduled traffic. The Frataring algorithm is a trip distribution technique that applies an iterative process to scale up the current origin/destination matrix according to the forecast year growth factor outlined in the TAF. The result of the Frataring algorithm is a scaled-up origin/destination matrix that contains the future number (the current number plus future increment) of scheduled flights from each origin to each destination.

The origin/destination matrix of current flights is subtracted from the Fratared origin/destination matrix to produce an origin/destination matrix of only the future flights. The origin/destination matrix of future flights contains the number of future

---
[1] This appendix was developed by Doug Baart (Tech Center/ACT-520) and Diana Liang (FAA/ASD-400).
[2] Source – Emissions and Dispersion Modeling System Reference Manual; FAA; April 1997
[3] Source – Design of NASPAC Simulation Modeling System; David Millner; MITRE/CAAS; June 1993

scheduled flights from each origin to each destination that are to be generated by the Future Demand Generator. This matrix is an input to an algorithm that schedules these future flights and strings them together into aircraft itineraries.

The scheduling algorithm breaks the day into discrete time slots (e.g., 5 minutes) and assigns a value to each slot based on the current traffic congestion at the departure and arrival airports. The most valuable slots are those that are near current traffic peaks and that are not above capacity. Generally future flights are scheduled near existing traffic peaks. Average en route and turnaround times vary by aircraft class (i.e., jets and propeller-driven) and are used in the itinerary building logic.

The process for generating future unscheduled traffic is analogous to the scheduled traffic generation process described above. The differences are pointed out here. One difference is that the input data is produced from Host Z data. It contains records for the unscheduled IFR flights for a particular day. Another difference between the scheduled and unscheduled processes is in the airports at which traffic growth is forecast. The origin/destination airports, for which unscheduled IFR traffic growth is forecast, are approximately 400 airports that currently have the largest number of unscheduled IFR operations.

NAS Performance Analysis Capability (NASPAC)

The NASPAC SMS is a discrete-event simulation model that tracks aircraft as they progress through the NAS and compete for ATC resources. NASPAC evaluates system performance based on the demand placed on resources modeled in the NAS and records statistics at 72 of the busiest airports plus eight associated airports. NASPAC simulates system-wide performance and provides a quantitative basis for decision-making related to system improvements and management. The model supports strategic planning by identifying air traffic flow congestion problems and examining solutions.

NASPAC analyzes the interactions between many components of the ATC system and the system reaction to projected demand and operational changes. The model is designed to study nation-wide system performance rather than localized airport changes in detail; therefore, airports are modeled at an aggregate level. The model shows how improvements to a single airport can affect other airports in the NAS through the propagation of delay. An aircraft itinerary may consist of many flight legs that an aircraft will traverse during the course of a day. If an aircraft is late on any of its flight legs, successive flight legs may be affected. This is the way the model captures the rippling effect of passenger delay. The model does not reroute traffic or impose speed changes to flights because of adverse weather.

NASPAC records two different types of delay, passenger delay and operational delay. Passenger delay, which is not evaluated in this analysis, is the difference between the scheduled arrival time and the actual arrival time as simulated by NASPAC. Operational delay is the amount of time that an aircraft spends waiting to use an ATC system resource

Key output metrics recorded in the model include delay and throughput at airports, departure fixes, arrival fixes, restrictions, and sectors. This reporting is done system-wide and at all modeled airports. Operational delay consists of airborne and ground delay. Airborne operational delay is the delay that a flight experiences from competing for airborne ATC resources. Ground operational delay accumulates when an aircraft is ready to depart but has to wait for a runway to take off. It also occurs when airfield capacity limitations prohibit the aircraft from landing. Operational delay contributes to passenger delay and is assigned to the airport to which the flight is destined. Sector entry delay occurs when the instantaneous or hourly aircraft count parameters for that sector are exceeded. Sector capacities for each of the 756 sectors modeled were provided by FAA's Air Traffic organization.

Optimized Trajectory Generator (OPGEN)

OPGEN is another component of the NARIM system. The tool is used to produce 4-D flight trajectories base on the user objectives. The user objective may be to create flights that are optimized for wind and special use airspace (SUA) and use minimum fuel. The input requirement includes wind aloft information, aircraft performance, SUA activities, origin and destination and any operation procedures and cutoff level. The model uses a genetic algorithm for searching the optimized flight trajectory that meets the user requirements. The output is a formatted file with aircraft information, ID, origin and destination, interval latitude, longitude, altitude, and speed. The output from OPGEN can then be used as input to NASPAC or used to calculate fuel burned.